

**The Uniqueness of Adjacent Beaches
for Tsunami Mitigation Efforts
- A Case Study from Phuket, Thailand**

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Introduction

DEWS will provide advanced information of impending tsunami arrival at beaches and coastal areas around the Indian Ocean.

It is proposed in this paper that simulation of the possible effects of such tsunami from a variety of source locations, directions and magnitudes be carried out.

These simulations can be used in conjunction with the tsunami warning from the DEWS system, to predict the likely specific consequences for beaches, initially in Phuket, but later for other locations in Thailand and for other countries likely to be affected.

Based on the events of 26 December 2004, something like 90 minutes may be available to be used for prediction of consequences for a particular beach.

Local advice, over and above a general tsunami warning may be given, perhaps enhancing the survival possibilities and possibly reducing damage.

Local Beaches in Phuket

It was observed by the authors, that the tsunami wave had rather different impacts at three different beaches in Phuket.

Visits to Patong Beach, Kamala Beach and Surin Beach, 4 weeks after the event, clearly indicated rather different consequences for those present at the time.

This is perhaps surprising, bearing in mind the rather short geographical distances between the beaches.

However, subsequent research, reported here, provides us with possible explanations for why this is so.

What follows describes the provisional results of a more recent detailed examination of the possible reasons for this.

Current Work

Evaluation of some specific beaches in respect of:

Size and Shape

Orientation

Shelving gradients

Surface and Seabed Features

Horns at Beach Ends

Consequences of Geographical Features

Principle West Coast Beaches:

Surin

Kamala

Patong

Additional Beaches:

Nai Yang - North West Coast, near Airport

Rawai - South East Coast

Phuket Island

Nai Yang Beach



Tsunami Wave Direction



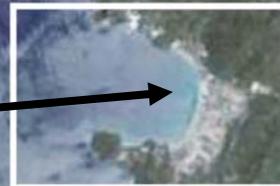
Surin Beach



Kamala Beach



Patong Beach



Rawai Beach



19.5 km

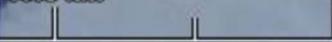


Image NASA

Image © 2008 DigitalGlobe

Surin Beach



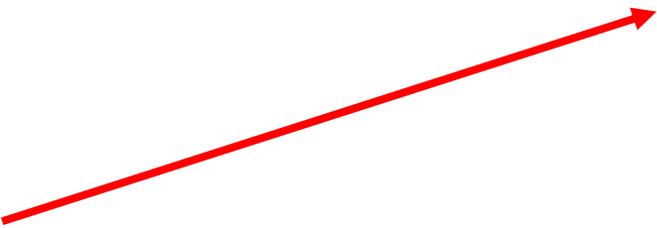
Surin Beach from Nok Restaurant

Surin Beach

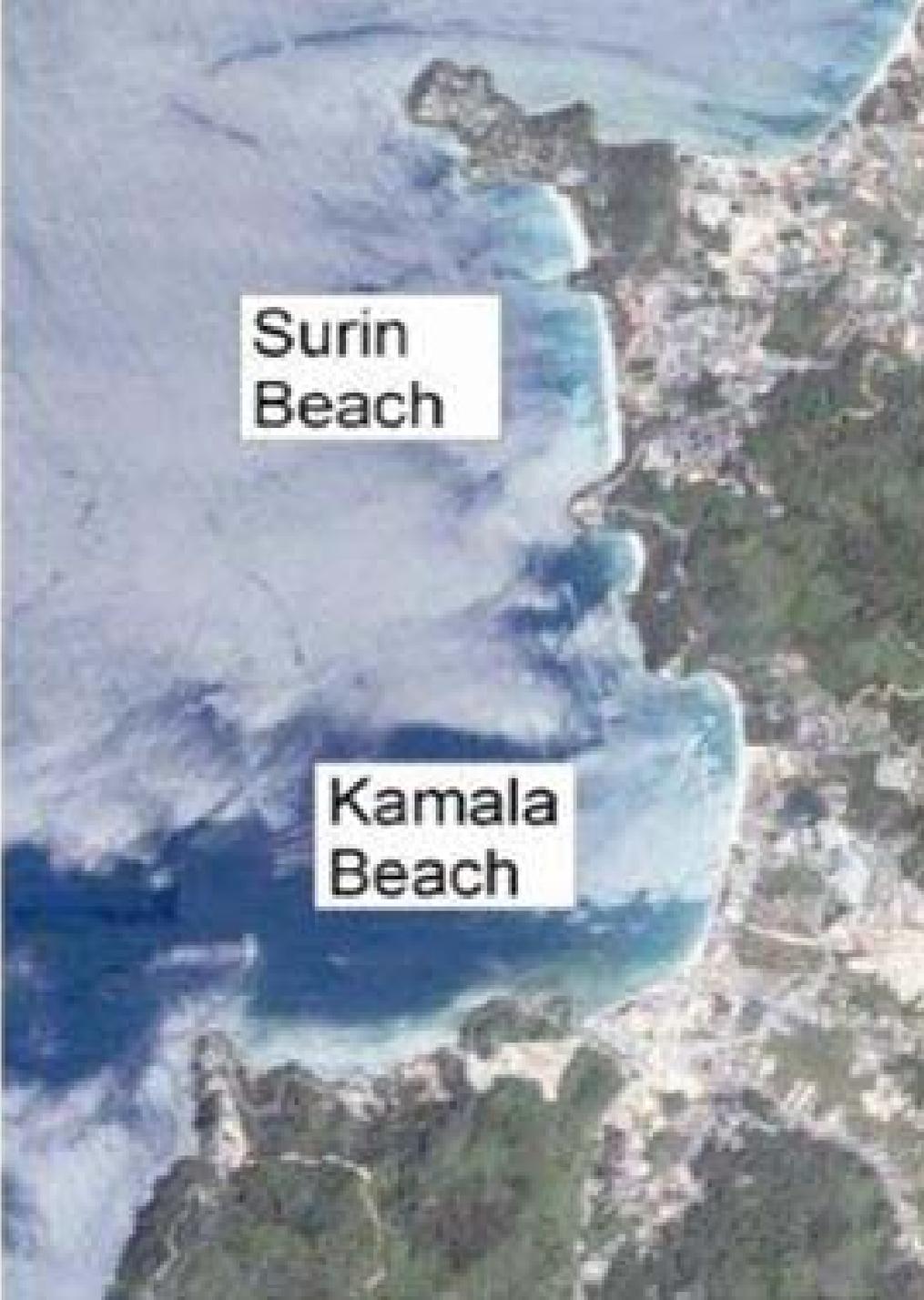


Surin Beach Showing Shelving Sand and Southern Arm

***Detail of Surin Beach
and Kamala Beach***



Direction of Tsunami Wave



Special Considerations of Surin Beach 1

Considerable Shelving

The restaurant is some 2m above the sand.

The sand slopes gently and then more steeply in several sequences.

December to March it is safe to swim, because of calm seas.

Outside of this, the surf causes landing problems for swimmers on steeper slopes due to fluidized bed effects for some tidal states.

However, the tsunami rose up less and was not so damaging due to the steeper shelving and height of the restaurant and car park above the sea level.

Special Considerations of Surin Beach 2

Some open structure bamboo beach huts, used for lunch and evening meals, were undamaged and remained in place on the beach.

In relation to the angle of attack of the tsunami wave, the Southern horn of the beach protected the beach, even though it is probable that some overtopping of the rocky shore extension would have occurred.

However, these aspects undoubtedly gave significant protection to the beach.

Attacks from a more Westerly or North Westerly direction might well have been more damaging. However, the steepness of the sea bed will always help to reduce the effects of a tsunami.

Kamala Beach



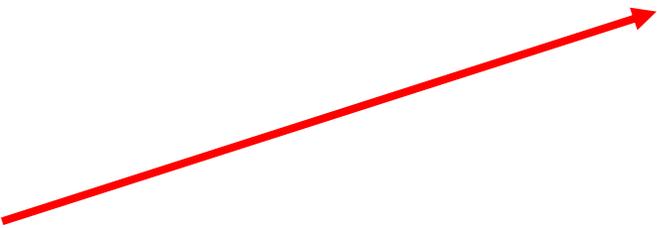
Kamala Beach from the Beachside Accommodation

Kamala Beach

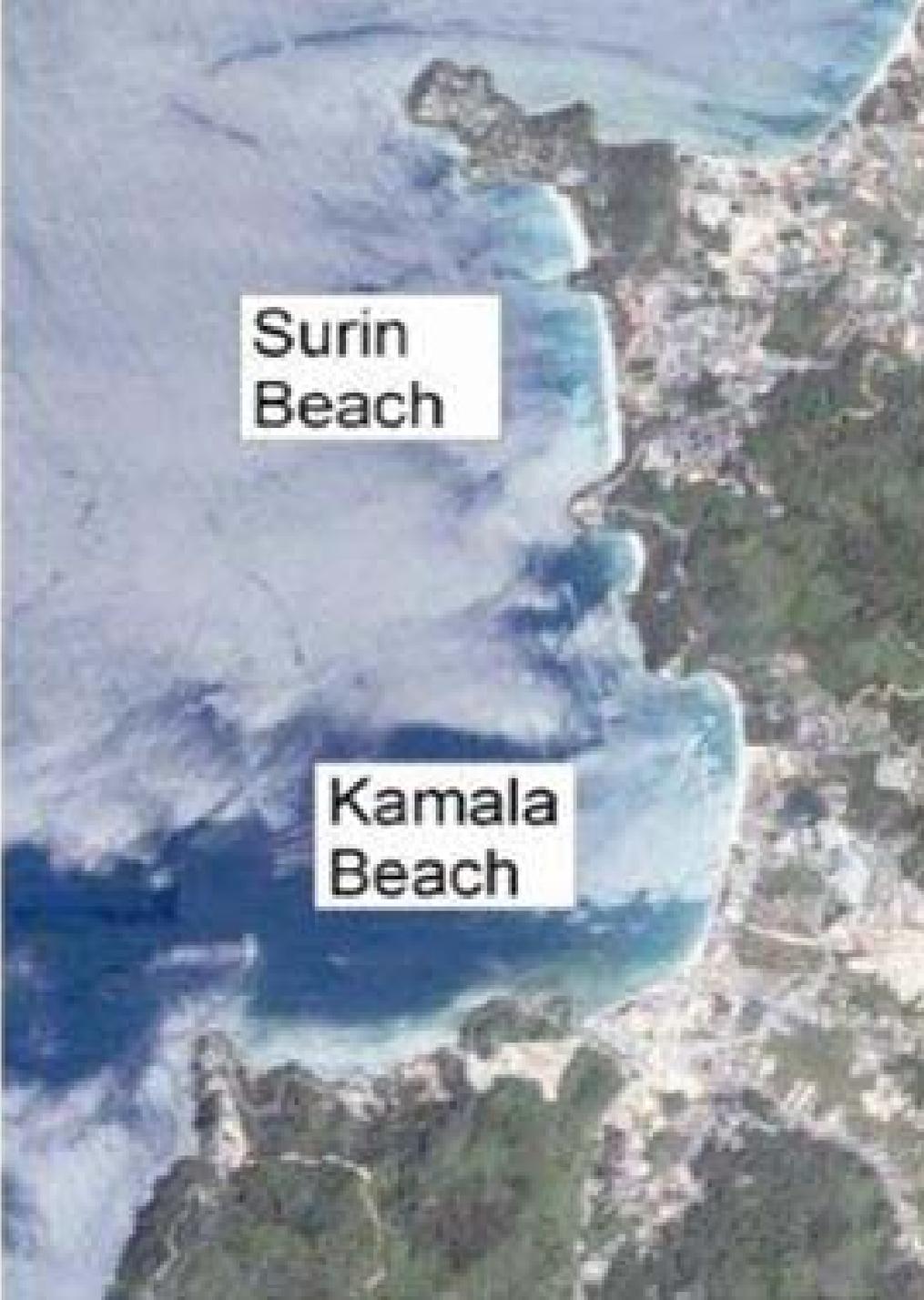


Northern end of Kamala Beach

***Detail of Surin Beach
and Kamala Beach***



Direction of Tsunami Wave



Special Considerations of Kamala Beach

The school was completely destroyed by the tsunami wave, leaving only a patch of concrete.

Now, the school has been completely rebuilt as a strong multistory building.

This will provide a local escape facility for children and teachers. It also provides a possible refuge for others seeking escape from a tsunami following an alert from DEWS.

The canal divides the beach and also deposits silt from inland, which is evident from sampling of the sand at low tide at the southern end.

Observation of flow of the canal through the beach also provides a good educational example of real-time river erosion.

Kamala Beach



Rebuilt School in Kamala

Kamala Beach



Canal Entering Kamala Beach



*Direction of Tsunami
Wave*

Patong
Beach

3.45 km

Image © 2008 DigitalGlobe

Google

Feb 28, 2006

Eye alt 11.94 km

lat 7.902979° lon 98.277553°

Detail of Patong Beach

Patong Beach



Southern Aspect of Patong Beach

Patong Beach



Northern View of Patong Beach

Special Considerations of Patong Beach 1

This is the largest tourist beach in Phuket with a length of about 1.5km. It has substantial horns, giving some protection. However, the low shelving of the seabed and beach allowed the tsunami wave to arrive at a damaging height of around 6.5m.

The beach road has single storey buildings with side parking on both sides of the road. The consequence of vehicles being picked up by the wave and deposited in restaurants was devastating.

There are a few roads (soi) at right angles serving the beach from the main Patong road, these fortunately have a significant slope, so that escape by walking up these road is possible. Escape is also easy up the steep roads at the south and north extremities of the beach.

Special Considerations of Patong Beach 2

This curved beach lies roughly South to North.

The southern horn provided some initial relief from the wave which arrived from a West-SouthWest direction.

This was reflected back towards the southern horn, but encountered a subsurface rocky peak, clearly seen in the video. The authors believe that this is perhaps what gave rise to enormous and dangerous whirlpool also seen in the video.

Perhaps removal of this undersea feature might reduce the damaging effects of such a vortex.



***Detail of
Rawai Beach***

***Direction of
Reflected
Tsunami Wave***



Rawai Beach



Rawai Beach



Rawai Beach from Beach Restaurant

Special Considerations of Rawai Beach

This beach is on the South East coast of Phuket, facing the mainland shore of Krabi.

It received the reflected wave from the Krabi shore, but this was further attenuated by the proximity of an offshore island as shown in the previous pictures. Here it is clear that the beach also exhibits significant shelving.

Further, the picture from the beach restaurant, clearly shows that the beach road, and the restaurants and shops behind it, stand at least 1m above the top of the beach.

Further to the North near to the Zoo, there are several substantial beachside seafood restaurants, of some quality and reputation. These suffered much damage, and there was also a lot of sand deposited on the road behind and beyond.



Airport

Nai Yang
Beach

**Nai Yang Beach Showing Proximity of Phuket Airport.
The Arrow Indicates the Direction of the Tsunami Wave.
The Star Shows the Popular Tourist Area.**

Nai Yang Beach



Nai Yang Beach Southern End, Showing Extensive Horn

Nai Yang Beach



Nai Yang Beach Northern End, by the Airport

Special Considerations of Nai Yang Beach

This beach is to the West and South of the Airport. It is less developed and popular, only because of its distance from the main tourist beaches.

The Southern half has a lovely beach with good swimming and excellent seafood restaurants. The horns of the beach are visible at low tide, from which local people collect cockles and mussels, to be eaten that evening.

This part of the beach was protected because of it was at right angles to the direction of the tsunami, although overtopping will have occurred at the horns.

The Northern end of the beach exhibits significant shelving and this, together with a step up of at least 1m to the land behind, protected the Airport from significant damage.

Local Observations

Observations of local Thai people provide useful insights to what actually happened at specific beaches.

Measurements of slope and shelving and the height of the land behind at specific beaches, together with the nature of horns at the beach ends provides clues to susceptibilities to future tsunami.

Collection of sand samples at low tide have been taken to assist with establishing likely movements of sand under the sea and on to land. Estimates of particle size, density and roughness were obtained for future work.

Modelling and simulation

The basis of equations and approximations will be obtained from existing papers and sources in respect of, especially in connection with estuarine silt transportation and deposit.

However, it is recognized that for tsunami waves Reynolds numbers are very much greater and scaling may not be possible.

These considerations also suggest that results obtained from testing in flumes and wave basins may not be scalable.

This also implies that validation may be somewhat difficult.

Perhaps the ability to reproduce existing simulation results of other groups may provide some confidence in this difficult area.

Conclusions

Modeling and simulations of possible future tsunami arising from major sub sea geophysical events, would provide a database of scenarios.

A DEWS warning would allow selection of appropriate predictions to be used to evaluate likely consequences for specific beaches, based on tsunami height, direction and arrival time.

This in turn would perhaps allow for more effective defensive actions to be taken locally.

Other tsunami sources, such as storm surges, landslides and meteorites, may not necessarily provide good predictions.